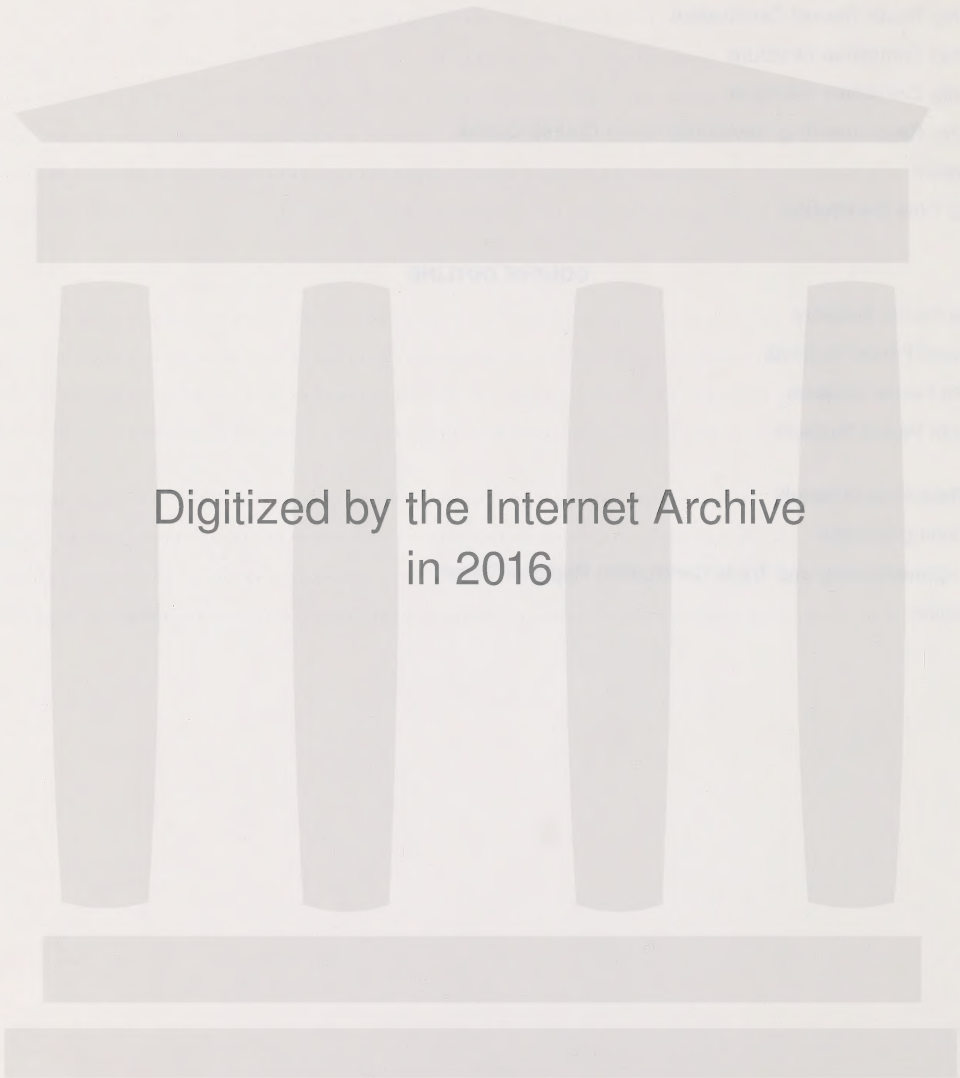
APPRENTICESHIP TRAINING

REFRIGERATION MECHANIC Program

Alberta
MANPOWER
Apprenticeship and Trade Certicication

TABLE OF CONTENTS

COURSE OUTLINE



REFRIGERATION MECHANIC TRADE

THE GOAL OF APPRENTICESHIP TRAINING

To develop a competent tradesman who, through skill and knowledge, is capable of installing and maintaining units or systems used for the provision of refrigeration and air conditioning.

THE PRODUCT OF APPRENTICESHIP — a graduate who is able to:

★ Have a thorough knowledge of the principle components of refrigeration systems, heat cool units and air conditioning.

★ Have a thorough knowledge of electrical and automatic controls used in all aspects of the refrigeration and air conditioning industry.

★ Be capable of assembling, installing or overhauling all components.

★ Have an intimate knowledge of other mechanical trades which contribute to refrigeration and air conditioning systems.

★ Be familiar with the work of other tradesmen in the construction industry.

★ Be proficient in the use of test instruments.

★ Exercise good judgement and resourcefulness in construction, maintenance and Occupational Health and Safety.

REFRIGERATION MECHANIC
APPRENTICESHIP INFORMATION

Basic Requirements:

★ Indenture for four periods of Trade experience and training.

★ Attend an eight week technical training course in the first, second, third and fourth periods.

★ Fulfill the requirements for each period including 1800 hours of work experience inclusive of time spent at the training course; successfully complete the technical training course and obtain a satisfactory employer's report.

★ Education — a minimum requirement is the completion of grade 9 or a pass on an equivalent entrance examination as prescribed by the Trade Regulation. (Emphasis on Math and Physics is advisable)

★ Age — the minimum age for apprentices is 16 years. There is no upper age limit.

Credits:

★ Accelerated patterns of apprenticeship may be granted for related technical training and/or experience.

Benefits:

★ Apprenticeship is a learning-while-earning program. While working at the trade during apprenticeship, apprentices are assured by regulation of a minimum percentage of journeyman rates; 50% during first period, 60% during second period, 75% during third period, 85% during fourth period. Progress from one rate to the next takes place only after successful completion of all the requirements for each period.

★ All apprentices 17 years of age and older are normally eligible for training allowances while attending technical training courses. These allowances are funded by the Canada Employment and Immigration Commission.

★ Administrative procedures establishing the amount of training allowance is complex and can vary with an individual's circumstances. Contact a local Canada Employment Centre for details.

★ An apprentice who successfully completes the program will graduate with an Alberta Completion of Apprenticeship Certificate and a Journeyman Certificate of Proficiency. It is also possible for the graduate to obtain an interprovincial Red Seal by passing an additional examination and so become recognized as a qualified tradesman throughout Canada.

★ The most significant benefit to the graduate apprentice is that he is well trained in technical and practical aspects of the trade and is able to make a worthwhile and productive contribution to society. Society in return, will provide an opportunity for an above-average income and successful livelihood.

DIRECTIONS FOR PROSPECTIVE APPRENTICES

★ Contact your nearest Apprenticeship and Trade Certification for detailed information and counselling (see list of offices on page 49).

★ Obtain application forms in duplicate from the Apprenticeship and Trade Certification and neatly complete, on both copies, the information requested from the apprentice.

★ Contact in person firms that employ Refrigeration Mechanics and apply for an apprentice position. Present your apprentice application forms to the person who interviews you so that he will know who you are and what you can offer his firm.

★ Persevere in the search for apprentice employment and upon obtaining employment, leave the application with the employer.

★ Attach to the apprentice application a copy (transcript) of the marks for your last year of school. Applicants who do not have their school transcripts or a grade nine standing are required to write an entrance examination. If transcripts have been lost, contact Alberta Education for information on school transcripts.

★ Any time credit, for previous experience in the Refrigeration Mechanic trade, should be discussed with the employer and requested on the application forms by the employer.

★ A contract of apprenticeship is entered into between the apprentice and the employer and should be signed within three months after the apprentice applications have been approved. If contracts have not been issued within this time, contact the Apprenticeship and Trade Certification Office.

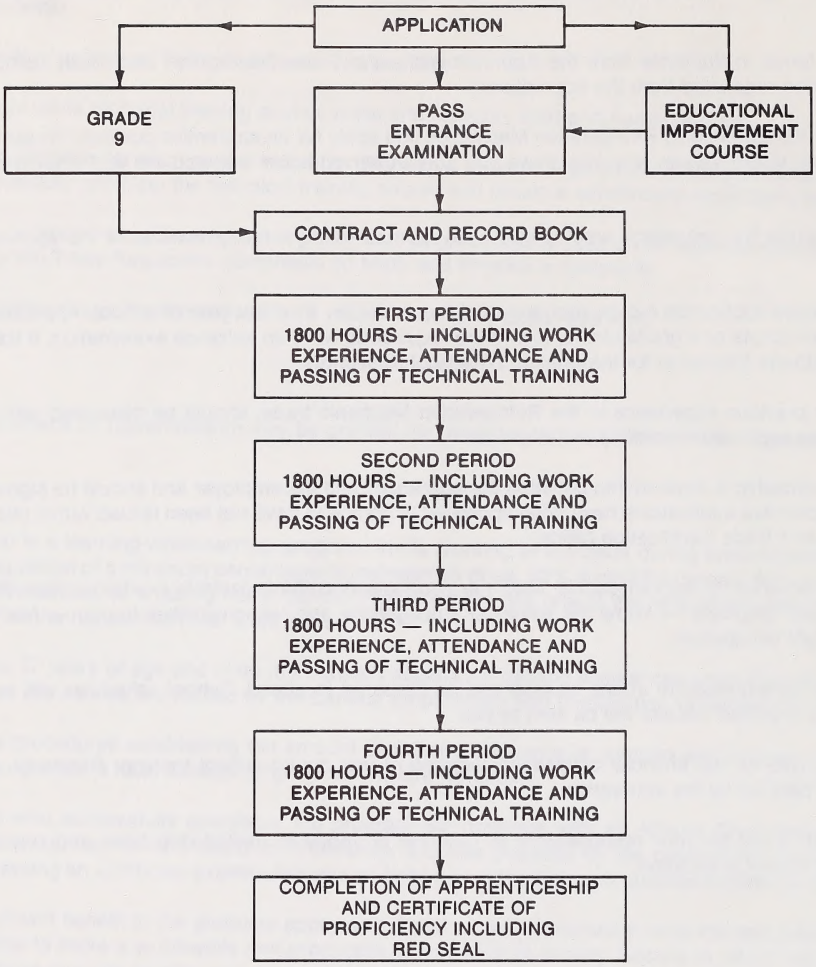
★ Before signing the contract of apprenticeship read the complete document carefully — know your obligations and responsibilities to your employer — know the employer's obligations and responsibilities to you — feel confident you have selected the right occupation.

★ Know when you will be expected to attend classes and be prepared to attend. School schedules will be sent to your employer and notice to attend classes will be sent to you.

★ PREPARE IN ADVANCE for the financial obligations required of you during school training. Reference materials and school supplies are paid for by the apprentice.

★ While an apprentice, it will be your responsibility to respond promptly to mailed directions and requests from the Apprenticeship and Trade Certification.

APPRENTICESHIP ROUTE TOWARD CERTIFICATION



APPRENTICESHIP COMMITTEE STRUCTURE

Refrigeration Mechanic Provincial Apprenticeship Committee

The Provincial Apprenticeship Committee for the Refrigeration Mechanic Trade is comprised of members from Local Apprenticeship Committees from the cities of Edmonton and Calgary.

This Committee is concerned with the policies that guide the program and make recommendations to the Apprenticeship and Trade Certification Board and the Executive Director of Apprenticeship and Trade Certification in the following areas:

- ★ Contribute current information relative to changes in the trade and requirements of industry.
- ★ Make recommendations for changes to existing trade regulations.
- ★ Assist in updating of the training program through recommendations for revisions to the course outline and attendant examinations.

Refrigeration Mechanic Local Apprenticeship Committee

Local Apprenticeship Committees are concerned with individuals and trade situations within a local region. Meetings are held throughout the year to make recommendations and to discuss problems relating to the apprenticeship program. Members who serve on committees are nominated by employer and labour organizations, and membership is equally divided into employer and employee representation in accordance with The Manpower Development Act.

Apprenticeship Committee Members:

Mr. K. Burger — Edmonton — Employee (Alternate)
Mr. W. Koshman — Edmonton — Employer (Alternate)
Mr. W. Lowrie — Edmonton — Employer
Mr. J. Ohe — Edmonton — Employer
Mr. B. Wells — Edmonton — Employee
Mr. D. Duchak — Calgary — Employee (Alternate)
Mr. A. Hettinger — Calgary — Employer
Mr. J. Mitchell — Calgary — Employee
Mr. J. Montgomery — Calgary — Employer
Mr. A. Sorochak — Calgary — Employer
Mr. G. Vachon — Calgary — Employer (Alternate)

REFRIGERATION MECHANIC PROGRAM
COURSE OUTLINE

This outline has been prepared in accordance with recommendations from the Provincial Apprenticeship Committee for the Refrigeration Mechanic Trade in the Province of Alberta.

The outline was updated following consideration given to recommendations and suggestions from:

Local Apprenticeship Committees
Representatives from training institutes
Curriculum Sub-Committee of the Provincial Apprenticeship Committee

PROCEDURES FOR RECOMMENDING REVISION(S) TO THE COURSE OUTLINE

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to the Apprenticeship and Trade Certification, Edmonton.

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.

SAFETY EDUCATION

Safe working procedures and conditions, accident prevention and the preservation of health is of primary importance in the Apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of the government, employers, employees and the general public. Therefore, it is imperative that all parties become aware of circumstances that may lead to injury or harm and that safe learning experiences and environment can be created by controlling the variables and behaviors that may contribute to or cause an accident and/or an injury.

It is generally recognized that a safe attitude contributes to an accident free environment. As a result a healthy safe attitude towards accident will benefit an employee by helping to avoid injury, loss of time and loss of pay.

A tradesman is possibly exposed to more hazards than any other person in the work force and therefore, should be familiar with the Occupational Health and Safety Act and Regulations dealing with his own personal safety and the special safety rules applying to each job.

LEGAL AND ADMINISTRATIVE ASPECTS

Employer's Responsibilities:

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer. The company is responsible for:

1. The provision and maintenance of safety equipment
2. The provision of protective devices and clothing (as required by the Occupational Health & Safety Act, General Safety Regulations)
3. The enforcement of safe working procedures
4. Adequate safeguards for machinery, equipment and tools
5. Observance of all accident prevention regulations
6. Adequate training to allow a worker to use or operate equipment in an effective and safe manner.

Government's Responsibilities:

Apprenticeship and Trade Certification in conjunction with the respective Provincial Apprenticeship Committee assumes the responsibility to assure that adequate safety is reflected in the curriculum and that adequate safety instruction is presented at the training establishments.

The Occupational Health and Safety Inspection Branch assumes the responsibility for periodic inspection of the operation to ensure that regulations for industry are being correctly observed.

Individual's Responsibilities:

The employee is responsible for:

1. Knowing and working in accordance with the safety regulations pertaining to job environment and;
2. Working in such a way as not to endanger himself or his fellow employees

The major factor in safety is the individual employee, his personal attitude toward safety and having an awareness of the respective safety regulation.

REFRIGERATION MECHANIC PROGRAM

Subjects and Time Distribution

First Period	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Air Conditioning and Refrigeration Theory		88
Section Two:	Air Conditioning and Refrigeration Shop		64
Section Three:	Welding (Theory and Shop)		24
Section Four:	Electrical (Theory and Shop)		64
Second Period	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Air Conditioning and Refrigeration Theory		64
Section Two:	Air Conditioning and Refrigeration Shop		64
Section Three:	Electrical (Theory and Shop)		72
Section Four:	Controls		24
Section Five:	Blueprint Reading		16
Third Period	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Air Conditioning and Refrigeration Theory		80
Section Two:	Air Conditioning and Refrigeration Shop		64
Section Three:	Electrical (Theory and Shop)		56
Section Four:	Blueprint Reading		24
Section Five:	Controls (Theory and Shop)		16
Fourth Period	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Air Conditioning and Refrigeration Theory		72
Section Two:	Air Conditioning and Refrigeration Shop		72
Section Three:	Controls (Theory and Shop)		96

FIRST PERIOD TECHNICAL TRAINING
COURSE OUTLINE

SECTION ONE: AIR CONDITIONING AND REFRIGERATION THEORY **88 Hours**

TOPIC	COURSE OBJECTIVES
	Upon successful completion of each section the apprentice should be able to:
A. Applications	**2 Hours**
1. History	1. Describe the evolution of refrigeration and it's definition.
2. Scope	1. Recognize the need for refrigeration and air conditioning including: (a) cooling and preserving food (b) building environments (c) commercial refrigeration (d) industrial refrigeration
B. Basic Mathematics	**6 Hours**
1. Review (a) S.I. and Imperial Systems (b) Use of a Simple Calculator	1. Calculate whole numbers, fractions, mixed numbers, decimals; linear, square and cubic measure; area and volume calculations; ratio and proportion; weights and measures; percentage; metric system and conversion methods.
C. Physics (Imperial and S.I.)	**12 Hours**
1. Matter	1. Describe matter in it's three basic states: (a) solid (b) liquid (c) vapours
2. Energy	1. Define energy and describe it as to molecular movement: (a) kinetic (b) potential 2. Explain the basic thermodynamics of energy.
3. Force, Work and Power	1. Define force, work and power. 2. Describe the applied physics fundamental to the function of a refrigeration system. 3. Solve problems concerning force, work and power.
4. Pressure (a) units (b) measurement (c) gauge (d) absolute (e) scales and scale conversion (f) vapour pressure	1. Define pressure and describe the fundamentals of including those listed. 2. Convert absolute to and from gauge pressure. 3. List the instruments for indicating positive and absolute pressures.
5. Specific Gravity	1. Define specific gravity and relate it in physics to: (a) water (b) hydro-carbons — natural and liquified petroleum
6. Psychrometrics (Basics)	1. Describe the properties of air.
D. Occupational Health and Safety Regulations	**8 Hours**
1. Study of the Regulations	1. Learn the first aid regulations. 2. Be aware of general accident prevention regulations with emphasis on: (a) general safety precautions (b) housekeeping, personal protective equipment, clothing (c) respiratory protective equipment (d) confined space entry (e) electrical wiring and equipment

TOPIC	COURSE OBJECTIVES
	(f) powerlines (g) compressed and liquid gas systems (h) compressed air prohibition (i) explosive actuated fastening tools (j) refrigerants — hazards and safety precautions (k) grinding (l) use of safeguards (m) ladders (n) protection from falling materials (o) floor and roof openings, perimeter guardrails (p) temporary floor, temporary supporting structures (q) hoisting units — slings (r) over filling refrigerant and propane containers (s) working on burn outs, acids, etc.
2. Fire Prevention and Controls	1. Identify the types of fires and available extinguishers. 2. Define the critical areas in the industry. 3. Describe ways to prevent fires and work in safety.
3. Other Concerns	1. Outline emergency procedures and how to obtain assistance for the injured workman. 2. Know the procedures for obtaining first aid training and certification. 3. Describe the industrial health hazards: (a) fumes and skin contact with toxic substance (b) noise
E. Gas Laws	**2 Hours**
1. Boyle's Law 2. Charles' Law 3. Perfect Gas Law 4. Dalton's Law	1. Describe gas laws specifically related to the refrigeration system as follows: (a) Boyle's and Charles' Law (b) Combined Gas Law (c) Dalton's Law of partial pressures 2. Solve problems pertaining to the Gas Laws.
F. Heat	**12 Hours**
1. Definition	1. Define heat and describe the applied physics fundamental to the function of a refrigeration system.
2. Heat (a) sensible (b) latent (c) specific (d) fusion (e) vapourization (f) sublimation (g) superheat (h) subcooling	1. Define the different kinds of heat and how they relate to the function of a refrigeration system. 2. Describe the factors causing a change of state and relate these specifically to the refrigeration cycle.
3. Units of Measurement (Imperial and S.I.)	1. Define the following: (a) British thermal unit (b) ton of refrigeration (c) joule (d) kilowatt
4. Forms of Heat Transfer (a) conduction (b) convection (c) radiation (d) thermal quantities and transfers	1. Define the forms of heat transfer. 2. Perform practical experiments to reinforce the three heat transfer methods: (a) conduction (b) convection (c) radiation

TOPIC	COURSE OBJECTIVES
5. Temperature (a) scales (b) converstion	1. Describe temperature indicating instruments, thermometer types and installations. 2. Solve problems concerning temperature conversion. 3. Convert temperature readings to and from absolute temperatures.
6. Heat Content (Enthalpy)	1. Define heat content (Enthalpy) and its relationship to the refrigeration cycle and how it is measured.
7. Range of Flammability	1. Describe the limits of flammability of upper and lower percent of gas in the air/gas mixture that will support combustion.
8. Combustion Principles	1. List the elements that are necessary for the combustion of a gas. 2. Describe the causes, results and dangers of incomplete combustion.
G. Refrigeration Cycle	**8 Hours**
1. Basic Cycle	1. Identify and describe the essential components of the basic system. 2. Describe the mechanical cycle in detail.
2. Other Cycles	1. Identify the following cycles: (a) absorption (b) evaporative (c) vortex tube (d) thermal electric
3. Cycle Controls	1. Identify the basic refrigeration controls: (a) thermostat (b) pressurestat
H. Refrigerants	**10 Hours**
1. Definition	1. Define refrigerant.
2. Purpose	1. Explain the purpose of a refrigerant.
3. Classifications	1. Identify the different classifications of refrigerants.
4. Characteristics, Selection and Handling of: (a) R12 (b) R22 (c) R502 (d) R717 (e) propane(270) (f) other refrigerants	1. Read and interpret tables and charts. 2. Identify the refrigerants listed and their characteristic properties and determine the general applications for each. 3. Identify hazardous refrigerants and safety precautions. 4. Determine safe-handling methods for the refrigerant and its container. 5. Determine the correct procedures to: (a) determine the safe capacity for a service cylinder (b) transfer refrigerant into approved refillable containers (c) use scales and charging cylinders to determine the weight of refrigerant (d) identify the hazardous by-products or results of refrigerant combustion (e) identify and safely handle contaminated refrigerants 6. Identify cylinder colour coding.
I. Refrigerant Oils	**2 Hours**
1. Selection and Types	1. Read and interpret manufacturers' charts and tables. 2. Identify the characteristics of refrigerant oils such as: (a) viscosity (b) pour point (c) miscibility (d) wax content (e) flash point

TOPIC	COURSE OBJECTIVES
	3. Select refrigerant oil based on manufacturers' recommendations according to application requirements.
2. System Operation	1. Check the system for proper operating oil level.
	2. Identify the correct methods of adding or removing oils.
3. Handling and Storage	1. Determine the methods of handling and storing the oil safely.
	2. Identify correct clean-up procedures for: (a) oil spills (b) disposal
J. Compressors	**12 Hours**
1. Types	1. Identify the different types of compressors used in the refrigeration industry including: (a) reciprocating (b) rotary (c) centrifugal (d) screw (e) others
2. Principles of Operation	1. Identify operating principles of the following compressors: (a) reciprocating (b) rotory
3. Valves	1. Describe the types of compressor valves including: (a) ring plate type valves (b) flexing disc or reed type valves (c) discus
	2. Describe the action and arrangements of the valves and valve plates, suction and discharge valve operation.
4. Parts	1. Identify the parts of compressors and their function.
5. Lubrication	1. Identify compressor lubrication methods including the fundamentals of operation of the following: (a) splash feed (b) force feed
6. Capacity	1. Differentiate between theoretical and actual compressor displacement.
K. Evaporator Metering Devices	**12 Hours**
1. Capillary Tube	1. Identify and describe the construction and operating principles of the capillary tube.
2. Expansion Valves (a) hand (b) automatic (c) thermostatic (d) thermoelectric	1. Identify and describe the construction and operating principles of the types of refrigerant control devices listed.
	2. Describe the application of the metering devices listed.
	3. Establish the superheat reading of the T.X. valve.
	4. Name tools and equipment for: (a) removing and replacing the T.X. valve (b) testing and adjusting the T.X. valve
L. Floats	**2 Hours**
1. Refrigerant Floats	1. Identify and describe operation of floats.
2. Oil Floats	

TOPIC	COURSE OBJECTIVES
SECTION TWO: AIR CONDITIONING AND REFRIGERATION SHOP	**64 Hours**
A. Tools and Instruments	**10 Hours**
1. Hand Tools (Selection, use and maintenance of, but not limited to) (a) screwdrivers (b) wrenches: (i) pipe (ii) adjustable (iii) box/open end (iv) torque (v) socket (c) allen keys (d) scrapers (e) hacksaws (f) files and reamers (g) pliers (h) hammers (i) cutters and shears (j) drifts and punches (k) taps and dies (l) clamps and vises (m) pipe, stud, and bolt, extractors (n) drill bits (i) wood (ii) metal (iii) masonry	1. Identify the types of hand tools specified in terms of their: (a) size and design (b) application to specific materials (c) capacity (d) operating range 2. Determine the methods of assembling and adjusting the necessary hand tools. 3. Read and comprehend charts and tables for torquing. 4. Correctly perform preventive maintenance and identify and report defective hand tools for corrective action or replacement. 5. Determine the methods of using the hand tools for: (a) safe operation (b) restricted operations (c) the most efficient performance of the following: (i) threading (ii) holding (iii) fastening (iv) cutting (v) material removal
2. Refrigeration Tools (a) flaring (b) swaging (c) bending (d) cutting	1. Correctly select refrigeration tools based on: (a) type (b) size and design (c) capacity (d) operation 2. Correctly use refrigeration tools for: (a) type of operation to be performed (b) type of material to be used (c) dimensional restrictions in which to operate (d) necessary force to be applied (e) operating rate (f) most efficient usage 3. Maintain and store hand tools in safe working conditions.
3. Power Tools (a) select and use powertools of the following types: (i) electric drills (ii) electric hammers (iii) power saws (iv) impact wrenches (v) power grinders (vi) pipe cutting and threading machines	1. Correctly select and use power tools based on: (a) types (b) sizes (c) operating ranges 2. Correctly select and use accessories based on: (a) types (b) sizes (c) applications (d) tolerances (e) materials to be worked on 3. Perform all operations of power tools efficiently and safely. 4. Correctly perform preventive maintenance and identify and report defective power tools and accessories for corrective action. 5. Identify common hazards related to the use of power tools.

TOPIC	COURSE OBJECTIVES
4. Explosive Actuated Tools (An Approved Six Hour Course) (a) objectives	1. Course will provide instruction in (a) safety (b) uses and applications (c) care, maintenance and operation (d) practical experience in firing
(b) theory	1. Describe the high velocity and low velocity tools. Know how and why they operate. Be aware of the safety features and the different types of fasteners and charges. Learn the safety codes and regulations. State causes of misfire. 2. Identify the operator's responsibility. Demonstrate safe operation. Explain the relationships between pins, charges and materials. Discuss the hidden features of fastening surfaces.
(c) practical	1. Discuss servicing and storage of tools and supplies. Demonstrate minimum service of all common tools. Learn proper and safe storage of tools and charges and the disposal of misfired charges. 2. Demonstrate operation and the actual firing of a high velocity and a low velocity tool. 3. Operate — take part in both the prefiring routine and fire both high velocity and low velocity explosive actuated type.
(d) test	1. Receive a Certificate of Proficiency upon successful completion of course.
5. Test Instruments (a) hydrometers (b) thermometers (c) sling psychrometer (d) Orsat (e) Dwyer (f) manometer (g) pressure and vacuum gauges (h) fluid flow meters	1. Identify the various types of test instruments. 2. Demonstrate use of all test instruments listed.
B. Mechanical, Brazed and Soldered Connections	**24 Hours**
1. Soldering Equipment (a) acetylene (b) propane (c) safety considerations (d) torch applications (e) sweat joints	1. Demonstrate knowledge of soldering and brazing techniques and procedures using acetylene and propane. 2. Identify the type of flame used in brazing operations. 3. Set up and adjust equipment to braze and solder connections using the correct torch applications. 4. Demonstrate safe use of soldering equipment and practice safety. 5. State two reasons for having a chemically clean metal surface in brazing operations. 6. Describe two methods for removing oxides from a clean metal surface. 7. State the purposes of flux. 8. Identify and use different torch types. 9. Demonstrate the correct procedures and assembly of sweat joints. 10. Braze and solder joints between ferrous and non-ferrous pipe and tubing.
2. Pipe Fittings (a) thread types and sizes (b) use of cutters and dies (c) iron pipe joints (i) refrigeration equipment (ii) heat equipment	1. Identify and select fittings peculiar to the refrigeration trade including bends, elbows, flanges, tees, unions, couplings, valves, accessories. 2. Identify thread types and sizes and read basic selection charts for fitting sizes. 3. Select and operate required tools and equipment to cut, thread and ream pipe, tubing and flexible hose.

TOPIC	COURSE OBJECTIVES
3. Refrigeration and Heating (a) copper (b) steel (c) aluminum (d) plastic (e) quick connect	1. Specify the correct procedures for identification, basic sizing, fabrication, and installation of fittings. 2. Flare piping to form a leakproof joint between pipes and fittings. 3. Join or connect flexible hoses.
C. Valves	**2 Hours**
1. Purpose and Function	1. Identify and describe the functions of the following mechanical valves in the system. (a) two way service (b) three way service (c) globe (d) angle (e) ball (f) gate (g) needle valves (h) heating, natural and L.P. gas
D. Leak Detection Devices	**4 Hours**
1. Refrigerant (a) halide	1. Identify and correctly use a halide torch to detect refrigerant leaks. 2. Describe halide torch maintenance.
(b) electronic	1. Identify and correctly use an electronic detector to locate refrigerant leaks. 2. Describe it's range of sensitivity and principle of operation. 3. Describe electronic leak detector maintenance.
(c) bubble solution	1. Describe and demonstrate the use of bubbles to locate a leak.
(d) sulpher stick and litmus paper	1. Describe leak testing on ammonia systems with a sulpher stick and litmus paper.
E. Study the Operation of:	**24 Hours**
1. Commercial Installation	1. Describe and demonstrate evacuation procedures. 2. Describe and demonstrate system charging. 3. Describe the start up and operation of a commerical installation with special attention to its refrigerant flow.
SECTION THREE:	**WELDING (THEORY AND SHOP)** **24 Hours**
A. Theory	**12 Hours**
1. Personal Safety	1. Explain the use of eye and face protection equipment, gloves, sleeves, apron and welding boots for all cutting, welding and brazing operations.
2. Nature of Gases (a) oxygen (b) acetylene	1. Explain the characteristics of oxygen and acetylene and know the recommended handling methods for same.
3. Torches, Regulators and Hoses	1. Recognize the construction and function of regulators and hoses. 2. Explain the handling precautions for regulators and hoses. 3. Explain the construction and function of the torch and tips. 4. Demonstrate how to clean, store and take care of torch tips. 5. Explain torch malfunctions and how to correct same.
4. Cylinders	1. Identify the respective cylinders. 2. Explain the design of the cylinders and how these are to be handled and stored.

TOPIC	COURSE OBJECTIVES
5. Torch Setting, Adjusting and Balancing, Outfit Set Up	1. Describe the setting up and shutting down of oxy-acetylene cutting and welding equipment. 2. Select from a list the proper tip and rod size, acetylene pressure, and oxygen pressure for a given metal thickness. 3. State an acceptable lens shade number for oxy-acetylene welding and cutting. 4. Describe ventilation requirements for the welding of materials that give off toxic fumes and when welding in confined areas. 5. Identify oxy-acetylene welding and cutting equipment and accessories. 6. Match terms associated with oxy-acetylene cutting and welding to the correct definitions. 7. Describe the characteristics and uses of other fuel gases used for cutting purposes.
6. Flames (a) types (b) uses	1. Describe the types of flames, their purposes and uses.
7. Backfires and Flashbacks	1. Describe the special safety requirements to protect against flashbacks, fire, and explosions. 2. List causes of a backfire. 3. Describe the results of a backfire. 4. Describe the results of a flashback. 5. List in the proper order the steps to follow in case of a flashback. 6. List all the necessary equipment and protective measures to prevent fires when welding and cutting.
8. Silver Brazing, Fluxes and Joint Types	1. Describe the procedure for silver brazing and silver soldering joints. 2. State the purpose of flux and the types. 3. Describe and demonstrate the methods of applying flux and it's removal.
9. Hard Brazing	1. Correctly describe: (a) brazing techniques and procedures (b) flame type used in brazing (c) advantages and disadvantages of braze welding (d) characteristics of brazing rod
B. Shop	**12 Hours**
1. Setting, Adjusting and Balancing the Oxy-acetylene Torch	1. Set up equipment for oxy-acetylene cutting and welding. 2. Select from a list the proper tip size, adjust acetylene pressure, and oxygen pressure for a given metal thickness. 3. Turn on, light, adjust to a neutral flame, and turn off the oxy-acetylene cutting equipment. 4. Detect gas leaks and know how to correct such leaks.
2. Puddle and Flame Control	1. Demonstrate the ability to perform puddle welds on a mild steel with the proper flame control. 2. Identify and demonstrate three types of welding flames.
3. Beading and Adding of Rod-Butt Weld	1. Correctly and safely set up and adjust equipment to weld mild steel of a specified thickness including: (a) laying beads
4. Vertical Braze Lap Weld	1. Demonstrate the ability to perform lap welds on mild steel in the vertical position.

TOPIC	COURSE OBJECTIVES
5. Copper Filling With Easy-Flo and Sil-Fos	1. Demonstrate knowledge of "silver brazing" techniques.
6. Aluminum Brazing	1. Demonstrate knowledge of aluminum brazing.
7. Cutting	1. Perform straight line and bevel cutting on available mild steel. 2. Pierce and cut holes in mild steel plate.
SECTION FOUR:	**ELECTRICITY (SHOP AND THEORY)** **64 Hours**
A. Direct Current	**32 Hours**
1. Structure of Matter	1. Explain the fundamental relationship between the structure of the atom and the flow of electrons.
2. Conventional and Electron Theory 3. Magnetism	1. Describe the principles of basic magnetism including: (a) laws of magnetism (b) magnetic field, flux (c) magnetomotive force (d) reluctance (e) magnetic properties of iron (i) permeability (ii) saturation 2. Describe the relation between magnetic fields, electric current and voltage.
4. Application of Magnetism	1. Describe magnetism as it applies to the following: (a) relay operation and principle (b) buzzer operation (c) electric motor principle (d) generation of alternating current
5. Conductors (a) copper (b) aluminum	1. Define conductor with reference to electricity. 2. Define resistivity.
6. Insulators	1. Define insulators with reference to electricity.
7. Semi-Conductors	1. Define semi-conductors with reference to electricity.
8. Generations of E.M.F. (Basic)	1. Understand the methods used to generate AC and DC.
9. Electrical Units	1. Define quantity, express symbols and units of measurement for the following electrical terms: (a) Volts (b) Amperes (c) Ohms (d) Watts (e) Watthours (f) Coulombs (g) Joules
10. Ohm's Law	1. Describe the relationship of voltage, current and resistance in an electric circuit. 2. Solve problems using Ohm's Law. 3. Connect circuits and make voltage, current and resistance measurements to verify Ohm's Law.
11. Electrical Circuits (a) series (b) parallel (c) series — parallel (d) Kirchoff's law (e) three wire Edison circuit	1. Analyze and explain series and parallel circuits and identify their applications. 2. Apply Kirchoff's current and voltage laws to circuits. 3. Solve problems involving series, parallel and Edison three wire circuits. (balanced and unbalanced)

TOPIC	COURSE OBJECTIVES
(i) balanced and unbalanced (ii) neutral disconnected (f) voltage drop (g) line drop (h) schematic and wiring diagrams	4. Describe the effect that an open neutral will have on a customer's load (unbalanced and balanced). 5. Define and describe line loss and voltage drop as it applies to electrical power systems. 6. State the effects that an increase in load current has on the voltage at the load. 7. Solve applicable problems involving line loss and line drop. 8. Connect and take measurements of series and parallel circuits using schematic and wiring diagrams to verify Ohm's law.
12. American Wire Gauges	1. Identify wire sizes and know that different gauges of wire have different resistances.
13. Electrical Measuring Devices (a) Use, Care and Safety of Meters	1. Describe the proper care and safety precautions for: (a) ammeters (b) voltmeters (c) ohmmeters (d) megger 2. Demonstrate proper scale range selection and wiring connections. 3. Demonstrate accurate measurements.
14. Wheatstone Bridge	1. Describe the accurate resistance measurements in a circuit using the Wheatstone Bridge. 2. Solve introductry problems using the Wheatstone Bridge.
15. Power and Energy	1. Define power and energy. 2. State the units of power and energy. 3. Calculate electrical power. 4. Calculate electrical energy and cost.
16. Faults and Short Circuits	1. Describe and demonstrate proper procedures for locating electrical faults and short circuits. 2. Demonstrate the use of electrical measuring devices to locate and correct faults and short circuits.
17. Grounding of Equipment	1. Recognize the proper use of portable tools and the importance of grounding equipment.
18. Electrical Hazards	1. Identify electrical hazards, safe-working techniques and procedures when working with electrical circuits and rotating equipment, including: (a) proper use of tools (b) personal protective equipment (c) lock-out and tagging procedures
B. Basic Circuits	**8 Hours**
1. Simple Circuit Construction	1. Draw simple electrical circuits and symbols: (a) wiring diagrams (b) schematic diagrams
2. Shop Experiments	1. Use designs and connections for basic circuits.
C. Introduction to Basic Refrigeration Circuits	**24 Hours**
	1. Reading and demonstration of basic operations of a diagram.

SECOND PERIOD TECHNICAL TRAINING
COURSE OUTLINE

SECTION ONE: **AIR CONDITIONING AND REFRIGERATION THEORY** **64 Hours**

TOPIC	COURSE OBJECTIVES
	Upon successful completion of each section the apprentice should be able to:
A. Basic Refrigeration Principles Review	**6 Hours**
1. Producing Refrigeration Effect	1. Describe the methods of producing the refrigeration effect.
2. Vapour Compression Cycle	1. Describe the vapour compression processes.
3. Mechanical Compression Cycle	1. List and describe the essential mechanical components required.
4. Metering Devices	1. Identify the types of evaporator metering devices. 2. Describe the basic principles of operation of each.
B. Heat Transfer Surfaces	**18 Hours**
1. Review Heat Transfer Principles (a) conduction (b) convection (c) radiation	1. Define the forms of heat transfer. 2. Describe each as it applies to a refrigeration system.
2. Evaporators (a) direct expansion (b) flooded (c) liquid overfeed (liquid recirculation)	1. Identify and describe each evaporator according to the following uses: (a) air cooling (i) forced (ii) convection (b) liquid cooling (c) contact cooling 2. Describe the basic principles and the function of the evaporator in the system. 3. Describe the basic principles of superheating and saturation in the evaporator. 4. Describe the requirements for good evaporator design such as: (a) surface area (b) air flow (c) proper circulation of the refrigerant (d) acceptable pressure drop (e) design temperature difference
3. Condensers (a) air-cooled (b) water-cooled (c) dry-cooled (d) evaporative-cooled	1. Identify and describe each condenser according to the following uses: (a) air-cooled (i) forced (ii) convection (b) liquid cooling (c) contact cooling 2. Describe the function of the condenser in the system. 3. Describe the principles of de-superheating, condensing and sub-cooling. 4. Describe the purpose and operation of dry coolers used as secondary condensers.
4. Cooling Towers	1. Identify types and operating principles of cooling tower assemblies: (a) natural draft (b) induced draft (c) forced draft (d) closed-circuit coolers
5. Heat Exchangers	1. Refrigeration system: (a) Identify and describe the basic operation. (b) Describe advantages and disadvantages of having a heat exchanger in a suction and liquid line.

TOPIC	COURSE OBJECTIVES
	2. Heating systems: (a) Identify and describe the basic operation. (b) List conditions that will cause a heat exchanger to overheat in a heating system.
C. Pressure-Enthalpy Diagrams	**6 Hours**
1. Introduction	1. Read and plot a pressure enthalpy diagram for a simple refrigeration cycle.
D. Refrigerant Tables and Calculations	**10 Hours**
1. Review	1. Read and interpret refrigerant tables and solve related problems. 2. Identify and interpret the following refrigerant properties: (a) pressure-temperature conversion (b) specific volume (c) density
2. Basic Design Calculations	1. Identify and interpret the following data of a refrigeration cycle plotted on a pressure-enthalpy chart: (a) compressor refrigeration capacity (b) compression ratio (c) net refrigeration effect (d) volume of vapour to be pumped (e) weight of refrigerant required (f) required compressor displacement
E. Cycling Controls	**12 Hours**
1. Pressure	1. Explain the purpose of pressure controls. 2. Describe their location in the system. 3. Describe principle of operation and control adjustments.
2. Temperature	1. Describe the purpose of a temperature control. 2. Describe principle of operation and control adjustments.
3. Oil Pressure Safety	1. Describe the purpose and operation of an oil pressure safety control. 2. Identify the main parts of a control.
4. Altitude Correction	1. Describe the effect of a drop in atmospheric pressure on a control diaphragm or bellows. 2. Interpret tables and make adjustments to the control to correct for high altitude conditions.
5. Humidity	1. Describe the purpose and operation. 2. Identify the main parts of a humidity control.
F. Combustion of Hydro Carbon Fuels	**10 Hours**
1. Review	1. List the elements that are necessary for the combustion of a gas. 2. Describe the principle of combustion. 3. Describe the causes, results and dangers of incomplete combustion. 4. Demonstrate combustion testing.
2. Air Supply	1. Describe sources of air required for combustion, venting and ventilation. 2. Describe the reasons for venting products of combustion. 3. Describe venting and ventilation by gravity and power. 4. Describe problems that can occur in venting gas systems including: (a) spillage (b) condensation

TOPIC	COURSE OBJECTIVES
	5. Explain why dilution air is necessary to prevent: (a) negative pressure (b) down-draft
	6. Identify and describe the parts and accessories used for venting.
3. Gas Valves	1. Identify the different types of gas valves.
	2. Describe operation and servicing of gas valves.
4. Gas Flames	1. Describe the characteristics of gas flames: (a) colour (b) shape (c) intensity
	2. Describe the air-gas mixture used in heating-cooling units including: (a) aerated (b) non-aerated (c) post aerated
G. Code	**2 Hours**
1. B52 Mechanical Refrigerant Code (Latest Edition)	1. Correctly identify the applicable sections of the code, regulations and approved operating instructions covering the installation, maintenance and repair of refrigeration and air conditioning systems for the second period.
2. Gas Code	1. Correctly identify the applicable sections of the code, regulations and approved operating instructions covering installation and application for the second period.
SECTION TWO: AIR CONDITIONING AND REFRIGERATION SHOP	**64 Hours**
A. Metering Devices	**14 Hours**
1. Capillary tubes	1. Identify and describe factors that effect the selection for a given application.
	2. Describe service problems and perform the operations required to service and maintain capillary tubes.
2. Float Controls	1. Describe and perform the operations required to service and maintain floats.
3. Automatic Expansion Valves	1. Correctly test, remove, replace and adjust to specifications.
4. Thermostatic Expansion Valves	1. Correctly test, remove, replace and adjust a T.X. valve to specification.
B. Cycling and Protection Controls	**6 Hours**
1. Pressure (a) cycling (b) protection	1. Demonstrate the servicing and adjusting of controls.
2. Temperature (a) cycling (b) protection	1. Demonstrate the servicing and adjusting of controls.
3. Oil Pressure Failure Control	1. Demonstrate the servicing and adjusting of controls.
C. Introduction to Pressure Regulator Valves	**8 Hours**
1. Evaporator	1. Describe fundamental operation and function of each.
2. Crankcase	2. Perform systematic electrical and mechanical checks.
3. Discharge	3. Describe installation, service and maintenance procedures in accordance with manufacturer's practice.
4. Hot Gas By-Pass	

TOPIC	COURSE OBJECTIVES	
D. System Accessories and Components		**8 Hours**
1. Dehydrators and Filters	1. Describe the purpose of driers and filters including: (a) directional flow (b) size and type (c) replaceable core (d) pressure drop	
	2. Describe the properties of a desiccant.	
	3. Demonstrate installation, service and maintenance procedures.	
2. Oil Separators	1. Describe the construction, purpose and operation.	
3. Suction Accummulator	1. Describe the purpose, operation and construction.	
4. Solenoid Valves	1. Explain the construction and principles of operation.	
	2. Describe installation and service.	
5. Receivers	1. Describe the construction and function of a receiver in the system including: (a) applications (b) pressure-relief protection (c) relevant codes and data plate information	
E. System Evacuating and Charging		**6 Hours**
1. Vacuum Pumps	1. Describe and demonstrate use of pumps.	
	2. Describe pump care and maintenance.	
2. System Charging	1. Demonstrate adequate knowledge of safety procedures.	
	2. Demonstrate the procedures of charging.	
F. Hermetic Electric Devices		**6 Hours**
1. Hermetic Electric Devices: (a) relays (b) capacitors (c) inherent motor protection (d) overload protection (e) crankcase heaters (f) over current protection	1. For the devices listed: (a) describe the construction and operation (b) correctly troubleshoot	
G. General Piping Practices		**8 Hours**
1. Installation	1. Describe and demonstrate practices and principles involved in the installation of refrigerant piping.	
2. Pipefitter's Manual	1. Use the manual to determine proper offsets.	
H. Maintenance		**2 Hours**
1. Maintenance (a) evaporators (b) condensers (c) cooling towers (d) air washers	1. Describe and demonstrate service and maintenance procedures.	
I. Field Trips		**6 Hours**
1. Supermarket Installation	1. Observe and describe the system which will be a simple system with a remote condenser.	

TOPIC	COURSE OBJECTIVES
SECTION THREE:	**ELECTRICITY (THEORY AND SHOP)** **72 Hours**
A. Review D.C. — Series and Parallel	**4 Hours**
1. D.C. Series 2. Parallel 3. Series-Parallel 4. Voltage Drop 5. Line Drop 6. Power 7. Line Loss 8. D.C. E.M.F. 9. Kirchoff's Law 10. Generation of D.C.	1. Review and understand D.C. — series and parallel circuits from first period.
B. Single Phase Theory	**32 Hours**
1. Alternating Current (a) generation of A.C. (b) sine waves (c) phasors (d) peak and effective values (e) cycle and frequency	1. Explain instantaneous value. 2. Explain RMS or effective value. 3. Explain maximum or peak value. 4. Illustrate in phasor analysis directions and magnitude of phasors. 5. Define: (a) phasors (vectors) (b) phase (c) lead (d) lag (e) cycle and hertz (units of frequency) (f) angles of degrees (i) electrical (ii) mechanical
2. Resistance in A.C. (a) series (b) parallel (c) series-parallel	1. Solve problems involving series and parallel circuits with all possible combinations of resistance.
3. Inductance and Inductive Reactance	1. Describe inductance and the factors which affect inductance. 2. Describe induction and its effects. 3. Describe the DC inductive effects. 4. Describe the AC inductive effects. 5. Define inductance and state its symbol. 6. State the unit of measurement for inductance and its symbol. 7. Define inductive reactance and state its symbol. 8. State the unit of measurement for inductive reactance and its symbol. 9. Calculate the total inductance when inductors are connected in series or parallel. 10. State Faraday's law. 11. State Lenz's law. 12. Define time constant for RL circuit.
4. Capacitance and Capacitive Reactance	1. Describe the construction and characteristics of an elementary capacitor.

TOPIC	COURSE OBJECTIVES
	2. Describe capacitance and the factors which affect it.
	3. Describe capacitor types and applications.
	4. Calculate the value of a time constant for an RC circuit.
	5. Explain AC capacitive effects.
	6. State the unit of measurement for the charge of a capacitor and give its symbol.
	7. Define dielectric strength.
	8. Define capacitance.
	9. State the unit measurement for capacitance.
	10. Define capacitive reactance.
	11. Give the symbol for capacitive reactance and state its unit of measurement.
	12. Explain the equation for capacitive reactance.
	13. State the phase relationship between voltage and current in a capacitive circuit.
	14. Calculate the total capacitance for capacitors in series or parallel.
	15. Calculate the capacitive reactance of any given circuit.
	16. Solve problems involving resonance.
5. Impedance	1. Define impedance.
	2. State the unit of measure for impedance.
	3. State the components of an impedance triangle.
6. Power Factor	1. Define power and give its symbol.
	2. State the unit of measurement for power and give its symbol and unit of measurement.
	3. Define apparent power and give its symbol.
	4. State the unit of measurement for apparent power and give its symbol and unit of measurement.
	5. Define reactive power and give its symbol.
	6. State the unit of measurement for reactive power and give its symbol and unit of measurement.
	7. Define power factor.
7. Three-Phase A.C. Theory	1. Explain the generation of three phase voltages.
	2. State the advantages for three phase systems over single phase systems.
	3. Name the types of three phase connections.
	4. Define the term balanced three phase system.
	5. State the phase relationship for the 3 voltage in a three phase system.
	6. Apply Kirchoff's current and voltage laws to three-phase circuits.
	7. Solve power calculations in balanced three-phase circuits.
C. A.C. Circuits (Experiments)	**10 Hours**
1. Ohm's Law	1. Connect circuits and make voltage, current and resistance measurement to verify Ohm's Law.
2. Kirchoff's Law	1. Apply Kirchoff's current and voltage laws to circuits.

TOPIC	COURSE OBJECTIVES
D. Electrical Control Circuits for Refrigeration Systems	**18 Hours**
1. Drawing Circuits	1. Draw a schematic control diagram for a given project. 2. Use standard electrical symbols.
2. Tracing Circuits and Troubleshooting	1. Read and interpret schematic wiring diagrams. 2. Explain sequence of electrical operation. 3. Apply correct troubleshooting techniques and procedures to locate and confirm the system electrical failure(s). 4. Use electrical instruments to confirm electrical failure.
E. Power Factor	**4 Hours**
1. Demonstration	1. Define phase angler and give its symbol. 2. Draw phasor diagrams for various types of circuits. 3. Calculate: (a) power factor (b) power factor correction
F. Three-Phase Wye and Delta Connection	**4 Hours**
1. Demonstration	1. State and demonstrate by phasor analysis the relationship between E_{phase} and E_{line} for a wye system. 2. State and demonstrate by phasor analysis the relationship I_{phase} and I_{line} for a wye system. 3. State and demonstrate by phasor analysis the relationship between E_{phase} and E_{line} for a delta system. 4. State and demonstrate by phasor analysis the relationship between I_{phase} and I_{line} for a balanced delta system.
SECTION FOUR: CONTROLS	**24 Hours**
A. Basic Control	**24 Hours**
1. Basic Concepts	1. Define specific terms used in control. 2. Examine open and closed loops. 3. Examine control modes.
2. Evaluation of Control Systems	1. List the benefits of automatic control. 2. Describe loads and how they change. 3. List the criteria for good control.
3. Types of Control	1. Distinguish between regulator and follow-up systems. 2. Examine process control. 3. Differentiate between sequential, numerical, analog and digital control. 4. Differentiate between operating and safety control systems.
SECTION FIVE: BLUEPRINT READING	**16 Hours**
A. Technical Drawing Used by the Refrigeration and A.C. Industry	**8 Hours**
1. Nomenclature, Abbreviation, Standard Symbols	1. Identify the symbols, abbreviations and nomenclature used in a typical refrigeration or A.C. technical drawing.
2. Reading of Drawings: (a) line	1. Interpret and read line drawings.

TOPIC	COURSE OBJECTIVES
(b) isometric	1. Define isometric drawing principles. 2. Interpret an isometric drawing of a simple object given the corresponding orthographic views.
(c) orthographic	1. Identify the views in orthographic projection and their orientation. 2. Interpret dimensions of simple objects drawn to scale in orthographic projection.
(d) multi-view	1. Read multi-view drawings and interpret the types of lines used.
(e) section and detail	1. Read and interpret sectional and detailed drawings.
(f) standard symbols (i) welding (ii) electrical	1. Identify and interpret standard symbols used for electrical and welding drawings.
3. Simple Sketching and Dimensioning	1. Produce freehand sketches and schematics of technical drawings for the trade. 2. Use dimensional values pertaining to sketches.
B. Practical Exercise	**8 Hours**
1. Read Trade Blueprints (Refrigeration or A.C.)	1. Read and interpret blueprint and schematics drawings for design, installation, service and maintenance purposes. 2. Identify and interpret symbols.
2. Drawing of Schematic Diagrams (a) refrigeration or A.C. (b) legends	1. Draw schematic diagrams of refrigeration or air conditioning and actual simple jobs including legends.

THIRD PERIOD TECHNICAL TRAINING
COURSE OUTLINE

SECTION ONE: AIR CONDITIONING AND REFRIGERATION THEORY **80 Hours**

TOPIC	COURSE OBJECTIVES
	Upon successful completion of each section the apprentice should be able to:
A. Review Formulas and Calculations	**2 Hours**
1. Conversions (a) Temperature (b) Pressure	1. Read pressure-temperature charts for the following refrigerants: (a) R11 (b) R12 (c) R22 (d) R113 (e) R502 (f) R717 2. Given specific temperature and pressure conditions, use the pressure-temperature chart to establish the condition of the refrigerant. 3. Manipulate formulae to solve the problems given in worksheets. 4. Perform pressure and temperature calculations in Imperial and S.I. units and convert calculations between the two systems.
B. Psychrometrics	**15 Hours**
1. Psychrometric Chart	1. Review properties of air and interpret the psychrometric chart.
2. Chart Use	1. Solve problems using the chart involving: (a) heating and humidification (b) cooling and dehumidification
C. Refrigerant Load Calculations	**12 Hours**
1. Review of Heat Transfer (a) convection (b) conduction (c) radiation	1. Define the forms of heat transfer. 2. Describe each as it applies to a refrigeration or A.C. system.
2. Wall Gain (a) conductivity factor (b) over all conductance (c) transmission factors (d) conduction	1. Identify and calculate the transmission of heat gain (sensible) by: (a) walls, ceilings, floors, time factor (b) type of insulation (c) thickness of insulation (d) "U" factors (e) external architecture (f) temperature difference
3. Infiltration Loads	1. Describe and calculate infiltration (heat gain-loss). 2. Describe and calculate air changes.
4. Product Loads	1. Identify and calculate product loads with: (a) sensible heat (b) latent heat (c) heat of respiration
5. Supplementary Loads	1. Identify and calculate supplementary loads: (a) people (b) lights (c) motors (d) gas and/or electrical appliances
6. Total Load and Safety Factors	1. Calculate total load requirements including safety factors because of miscellaneous loads.

TOPIC	COURSE OBJECTIVES
D. Piping Selection	**10 Hours**
1. Refrigeration (a) basic principles	1. Read basic selection charts for line sizing. 2. Identify and select fittings peculiar to the trade. 3. Select piping arrangements for design factors for: (a) system capacity (b) oil return (c) refrigerant control (d) suction and discharge (e) temperatures (f) type of refrigerant (g) noise
2. Hydro-Carbon	1. Select piping in accordance with applicable codes and regulations. 2. Select piping size that will give minimum pressure loss or drop.
E. Multiplex Systems and Accessories	**10 Hours**
1. Multiple Evaporator Systems	1. Identify and describe the operating principles and applications of multiple-evaporator systems for: (a) single temperature (b) dual temperature (c) unbalanced cooling load (d) high and low humidity 2. Explain the fundamental differences between single and multiple-evaporator systems. 3. Identify the evaporator assembly accessories and establish the fundamentals of operation of each: (a) metering devices (b) evaporator pressure regulators (c) distributors (d) check valves 4. Explain the effect of humidity on the controlled area and the role of evaporator temperature difference between refrigerant and air in changing humidity conditions of the area. 5. Explain how any change of conditions at the evaporator will cause a definite change in the operating conditions of the system and on the relative humidity of the space.
2. Multiple Compressor Systems	1. Identify and describe the operating principles and applications. 2. Establish factors influencing compressor selection for: (a) low temperature (b) medium temperature (c) high temperature 3. Explain the differences between single and multiple compressor systems. 4. Explain purpose and operation of satellite compressors.
3. Accessories	1. Identify types and functions of accessories for multiplex systems.
4. Energy Conservation Systems	1. Describe energy conservation systems. 2. Describe principles of operation. 3. Describe the types and principles of controls on energy conservation systems.
F. Ammonia	**5 Hours**
1. Ammonia Controls (a) system valves	1. Describe stop valves including: (a) service and charging valves (b) isolating and bypass valves (c) location and function

TOPIC	COURSE OBJECTIVES
(b) refrigerant control	1. Describe the location and purpose of control valves for D.X. and flooded systems including: (a) solenoid and check valves (b) pressure regulators (c) liquid level controls (d) level alarms 2. Describe surge protection: (a) traps and accumulators
(c) control of oil	1. Describe oil and ammonia mixtures: (a) mixability (b) relative density of each (c) behavior of oil and ammonia 2. Describe oil separators and receivers. 3. Describe oil return to the compressors: (a) manual control (b) automatic control
(d) purging	1. Compare and explain differences in purging to hydro-carbon systems.
G. Defrosting	**8 Hours**
1. Principles and Controls (a) electric (b) hot gas (c) cool gas (d) reverse cycle (e) other systems (i) air (ii) water (iii) brine	1. Describe operating principles of defrosting sysems. 2. Identify the components and controls of the various defrost systems and determine the fundamentals of operations of each. 3. Describe installation procedures and layouts for the various defrost systems. 4. Explain the sequence of operations of refrigeration system defrost cycles for all methods indicated. 5. Read and interpret circuit wiring diagrams of the various defrost systems.
H. Regulators	**8 Hours**
1. Review (a) Evaporator Pressure Regulating Valve (b) Crankcase Pressure Regulator Valve (c) Discharge Pressure Regulator Valve (head pressure regulator) (d) Hot Gas By-Pass Valve	1. Describe the function and principles of operation. 2. Describe: (a) application (b) selection (c) adjustment
2. Pilot Operated Regulators	1. Describe the function and principles of operation.
3. Operational Problems	1. List causes of erratic action and hunting. 2. Describe effect of excessive pressure drop.
I. Food Preservation	**2 Hours**
1. Principles	1. Describe the causes of spoilage including: (a) enzymes (b) bacteria (c) micro-organisms (d) molds 2. Describe methods of preventing spoilage.
2. Cool Storage	1. Describe factors affecting storage life: (a) storage temperatures (b) humidity & shrinkage (c) product condition

TOPIC	COURSE OBJECTIVES
	(d) chilling before storage (e) packaging
3. Freezing	1. Describe freezing and frozen storage including: (a) freezing methods (b) frozen food and ice cream storage (c) importance of stable temperatures (d) packaging
4. Products	1. Describe cooling and freezing of: (a) meats (b) vegetables (c) fruits
5. Tables and Charts	1. Use tables and charts for properties of food products including: (a) specific heats (b) latent heats (c) optimum storage conditions (d) freezing temperatures (e) storage life
J. Thermodynamics	**4 Hours**
1. Ammonia System	1. Describe the ammonia system with respect to the laws of thermodynamics.
2. Measuring and Recording	1. Describe measuring and recording techniques with respect to the laws of thermodynamics.
3. Capacities and Efficiency	1. Calculate simple problems for finding capacity and efficiency.
K. Code	**4 Hours**
1. B52 Refrigeration Code 2. Gas Code	1. Correctly identify the applicable sections of the code, regulations and approved operating instructions covering the installation, maintenance and repair of refrigeration and air conditioning systems for third period. 2. Study and describe combustion process with special attention to gas flames and flame speed.
SECTION TWO:	**AIR CONDITIONING AND REFRIGERATION SHOP** **64 Hours**
A. System Components	**16 Hours**
1. Evaporators	1. Correctly install evaporator assemblies based on: (a) space requirements and mounting methods (b) location of the evaporator and location of the temperature sensor in relation to the evaporator (c) piping layout and drain facilities (d) specificed air flow (e) installation instructions 2. Connect electric motors and defrost system components. 3. Make the necessary pipe connections to: (a) refrigerant lines (b) drain and defrost lines based on pipe layout and installation instructions 4. Describe the correct method of repairing the evaporator assemblies as follow: (a) brazing and soldering (b) repairing or replacing fittings (c) combing or realigning of fins (d) replacing defrosting elements (e) repairing or replacing hangers (f) repairing or replacing fan blades and/or motors (g) reversing fan rotation (h) protecting fins in transit and during installation

TOPIC	COURSE OBJECTIVES
2. Condensers	1. Correctly mount condenser assemblies and identify the installation limitations and safety requirements as follows: (a) spacing requirements, mounting and isolating methods (b) required air flow(s) (c) solar and radiation aspects and prevailing winds (d) installation instructions (e) piping layout including drains, fire-relief lines (f) applicable codes and regulations
	2. Read and interpret wiring diagrams associated with condensers and their hardware.
	3. Describe the correct methods to repair and maintain the following types of condenser assemblies: (a) air-cooled (b) water-cooled (c) evaporative-cooled (d) refrigerant-cooled (e) cooling towers (pump assemblies) involving scale, corrosion, erosion, electrical and hardware failure, restrictive air flow
	4. Describe what happens to condensing pressures and temperatures when any of the following occur: (a) changes in refrigeration load (b) changes in air flow over the condenser (c) temperature variation of ambient condition (d) temperature variation of cooling water (e) change in condensing medium flow (f) changes of refrigerant flow in the condenser
	5. Describe methods used for low ambient control of condensing pressures and temperatures: (a) condenser flooding (b) fan cycling (temperature, pressure) (c) air volume (dampers, fan R.P.M.) (d) cooling towers (below 0° celsius)
	6. Select and operate measuring instruments for: (a) air temperature and flow (b) water temperature and flow
	7. Describe the safe-handling procedures for acids and solvents used for cleaning air-cooled and/or water-cooled condensers.
3. Condensing Units	1. Identify system components and accessories.
	2. Correctly install a condensing unit including: (a) leveling (b) fluid checks (c) wiring (d) control setting
B. Compressor Rebuilding	**18 Hours**
	1. Review the construction and operating principles of reciprocating compressors.
	2. Correctly trouble shoot a number of common compressor problems: (a) metal wear and fatique (b) mechanical failure (c) electrical failure
	3. Demonstrate oil testing and describe system clean up methods for compressor burn-out.
	4. Apply proper measuring techniques with respect to: (a) accurate piston size

TOPIC	COURSE OBJECTIVES
	(b) oversize determination (c) clearance (d) torquing 5. Apply the correct methods of repair: (a) replacement of crankshaft seals, gaskets, oil pumps, valve plates and piston assemblies (b) reassembling compressors following proper torque specifications (c) refastening and realigning of drives 6. Perform an efficiency check on a reciprocating compressor and record all malfunctions including: (a) procedure for oil level check and changing (b) operational shaft seal check (c) suction and discharge valve operation (d) check compressor for noise, vibration, abnormal low and high side pressures, overheating and security of mounting
C. Installations	**20 Hours**
1. Installations (a) single units (b) multiple units (c) automatic defrost units (d) two temperature systems (e) heat reclaim systems	1. Install the system based on manufacturer's recommendations and specifications including it: (a) be levelled and firmly mounted (b) have clean tubing and connections (c) have no leakage in the refrigerant lines and hold a vacuum of 500 microns (d) have no impurities in the refrigerant and the oil (e) have proper electrical and mechanical connections (f) have sufficient lubrication of moving parts (g) be installed according to installation codes and manufacturer's instructions 2. Select and operate the required tools for installation. 3. Identify the assemblies, accessories, and system components. 4. Install the system based on: (a) space requirements and mounting methods (b) piping layout (c) correct use of the following where necessary: (i) valves (ii) solenoid valves (iii) thermostats (iv) heat exchanger (v) surge tanks (vi) oil separator (vii) accumulator (viii) check valves (ix) diverter valves 5. Make the pipe connections including couplings and fittings to connect the refrigerant lines based on: (a) types and sizes of fittings (b) flared connections (c) hard and soft soldered connections
2. Review Charging and Operating Systems	1. List proper procedures for starting up a system. 2. Test system for leaks. 3. Determine proper procedures for safely pressure testing entire system using nitrogen/freon mixture. 4. Use correct pressure testing tools and equipment. 5. Describe six methods of leak detection. 6. Describe the correct method of purging the system.

TOPIC	COURSE OBJECTIVES
	7. List the hazards associated with purging: (a) environmental (b) property (c) personal (d) public
	8. Determine correct tools, equipment, and procedures for evacuating a system.
	9. Identify the types, sizes, and applications of vacuum pumps and vacuum measuring instruments.
	10. Determine correct method to operate the gauge manifold according to the function to be performed.
	11. Explain the meaning of: (a) micron range (b) sweep method (c) triple evacuation
	12. Explain the use of heat as an aid to dehydration.
	13. Determine correct location and position of equipment, valves and manifold valves.
	14. Select proper refrigerant and calculate quantity required for a system.
	15. Determine correct method to charge a system-operational high side, low side and non-operational high side: (a) scales (b) liquid charging cylinder (c) charts and graphs (d) liquid moisture indicator (e) frost line
	16. Determine the correct operational checks for: (a) drives, belts, couplings (b) oil levels, proper return (c) overcharge, undercharge (d) superheat (e) high-and low-side pressure (f) volts, amps, watts (g) air and water flow (h) vibrations (i) safety and operational controls functions
	17. State the sequence for safely and efficiently closing down system in relation to: (a) refrigeration cycle (b) water cycle (c) electrical cycle (d) tag control panel box
3. Bill of Materials	1. Prepare a bill of materials from job specifications.
4. Blueprints and Drawings	1. Read and interpret blueprints and drawings for installations and servicing data/instructions for but not limited to: (a) single and multiple units (b) automatic defrost (c) two temperatures systems (d) charging and operation of systems (e) heat reclaim systems
5. Job Specification	1. Read and interpret sample job specifications.
6. Special Installation and Service Problems	1. Describe methods of controlling high discharge temperatures.
	2. Explain the purpose and application of floating head pressure.
	3. Discuss other special problems.

TOPIC	COURSE OBJECTIVES
D. Ice Making Machines and Drinking Fountains	**4 Hours**
1. Ice Making Machines and Drinking Fountains	1. Describe principles of operation. 2. Describe and demonstrate installation procedures. 3. Describe service and trouble shooting procedures.
E. Field Trips	**6 Hours**
1. Industrial Installation	1. Describe the operation of an industrial system. (a) ammonia (b) refrigerant flow controls
2. Screw and Centrifugal Compressor Installation	1. Describe the operating principles of screw and centifugal compressors. 2. Explain advantages and disadvantages of these compressors.
SECTION THREE:	**ELECTRICITY (THEORY AND SHOP)** **56 Hours**
A. A.C. Theory	**4 Hours**
1. Review (a) single phase	1. Demonstrate knowledge and skills learned in second period for single phase theory.
B. A.C. Three Phase Theory	**8 Hours**
1. Generation of Three Phase	1. Describe generation of three phase.
2. Line and Phase Voltages	2. List and define the three phase connection methods.
3. Three Phase Power (a) reactive power (b) apparent power (c) power factor (d) three phase power factor correction	3. Describe the current and voltage relationships in wye and in delta. 4. Calculate three phase power, apparent power and reactive power. 5. Describe reasons for power factor and how it is calculated.
C. Transformers	**6 Hours**
1. Basic Construction	1. Describe the basic components of a transformer and the nameplate information. 2. List the purposes of a transformer. 3. Identify primary and secondary of a transformer. 4. Differentiate between a step-up and a step-down transformer. 5. Explain the standard terminal and winding identification.
2. Theory of Operation (a) cooling methods	1. Describe the various methods of cooling for transformers. 2. Identify liquids used for cooling.
(b) single phase transformers (i) mutual inducation (ii) split winding (iii) auto transformers	1. Describe and demonstrate connections for autotransformers. 2. Demonstrate ability to determine polarity. 3. Demonstrate identification of leads. 4. Demonstrate connections for single and three phase.
(c) Transformer Phasing (Paralleling)(Single Phase)	1. List the conditions to be met before operating two transformers in parallel. 2. Connect two transformers in parallel and check how they share the load.
(d) three phase transformers connections (i) voltage relationships (ii) hazards — backfeed (iii) ratio of transformer	1. Determine the expected secondary voltage by the use of a phasor diagram. 2. List the possible connections and changes that are to be made before hanging transformers in a bank.

TOPIC	COURSE OBJECTIVES
(iv) connection and proper fusing for: (Voltage) delta-delta wye-wye delta-wye open delta-open delta open wye-open delta delta-four wire delta	3. Decide, given the nameplate information, the supply voltage and required load voltage, the connection required. 4. Draw a connection diagram for the above. 5. Measure the secondary voltages.
3. Selection and Replacement	1. Correctly select and replace a transformer in accordance with service specifications.
4. Ratio Relationships (a) voltage (b) current (c) turns	1. State how transformers are rated and sized. 2. Describe and solve problems involving transformer voltage, turns and current ratios. 3. Explain the reason why transformers are rated in voltage and volt-amps.
5. Troubleshooting and Protection	1. Explain maintenance and test procedures, including oil testing. 2. Describe correct troubleshooting techniques and procedures to locate and confirm transformer failures.
D. Three Phase Motors	**14 Hours**
1. Types and Construction	1. Describe the main types of three phase motors, including: (a) squirrel cage (b) wound rotor (c) synchronous 2. State the functions of the principle parts of the squirrel cage induction motor, including: (a) stator (b) rotor (c) end bells and bearings
2. Theory of Operation	1. Explain the principle of operation. (a) squirrel cage (b) wound rotor 2. Demonstrate a rotating magnetic field. 3. Explain rotor frequency, slip, poles and RPM relationship. 4. Explain regulation and efficiency.
3. Starting Current Problems	1. State effect of rotor resistance on starting torque and starting current. 2. Describe the effect of power input and current at different loads.
4. Rotation Reversing	1. Describe and demonstrate procedures for changing the rotation of three phase motors.
5. Troubleshooting Motors	1. Demonstrate the following conditions: (a) low voltage (b) high voltage (c) over loading (d) blocked ventilation (e) single phasing (f) circuit breaker specifications
E. Single Phase Motors	**12 Hours**
1. Single Phase Motors	1. Understand the principles, characteristics and applications of single phase motors, namely: (a) split phase (b) capacitor start (c) capacitor start, capacitor run (d) permanent-split-capacitor

TOPIC	COURSE OBJECTIVES
	(e) shaded pole (f) synchronous (g) repulsion-induction 2. Demonstrate the different connection and methods of reversing. 3. Explain protective devices, including: (a) built in thermal (b) current relays (c) overload relays (d) potential relays 4. Describe and demonstrate motor troubleshooting for: (a) low voltage (b) high voltage (c) over loading (d) blocked ventilation (e) single phasing 5. Demonstrate the installation and adjustment of centrifugal mechanisms and starting switches. 6. Demonstrate the installation of solid state, current and potential relays as starting switches.
F. Motor Protection and Control	**12 Hours**
1. Three Phase Starters	1. Describe the purpose and principle of starters, including: (a) line (i) manual (ii) magnetic (b) reduced voltage (c) part winding (d) star delta (e) others 2. Describe controllers and grids for wound rotor motors. 3. Describe multispeed motor controller.
2. Single Phase Motor Starting	1. Describe and demonstrate single phase motor starting.
3. Protection	1. Describe motor protection from overloads. 2. Describe fusing for motor protection. 3. Describe causes of internal motor overload and protection against internal overloads. 4. Describe external motor protection. 5. Describe and demonstrate troubleshooting techniques for: (a) low voltage (b) high voltage (c) overloading (d) blocked ventilation (e) single phasing
SECTION FOUR: BLUEPRINT READING	**24 Hours**
A. The study of Blueprints and and Specifications on an Industrial Building	**6 Hours**
1. Typical Presentation of: (a) site (b) structural (c) architectural (d) elevation plans (e) mechanical	1. Read and interpret a set of building drawings for the design of a structure which includes a refrigeration system. 2. Review a complete set of drawings for: (a) site (b) structural (c) architectural

TOPIC	COURSE OBJECTIVES
	(d) elevation plans (e) mechanical
2. Trade Work	1. Study blueprints and isolate the Refrigeration Mechanics work. 2. Determine and note accommodation required for other trades that follow.
3. System Specifications (a) format (b) intent (c) content and information	1. Study sets of drawings which include plans, elevation(s) in order to assess: (a) equipment location (b) mechanical equipment (c) layout of duct system (d) layout of piping system and accessories (i) refrigerant (ii) condensate drains (iii) condenser water (iv) tower water
B. Reading Electrical Drawings	**9 Hours**
1. Point to Point Diagrams	1. Read and interpret electrical drawings with point to point diagrams.
2. Schematic Diagrams	1. Interpret wiring diagrams. 2. Explain sequence of electrical operation.
3. Reading of Electrical Drawings	1. Interpret terms used in electrical drawings. 2. Identify Symbols.
C. Reading Air Conditioning Drawings	**9 Hours**
1. Symbols and Terminology	1. Identify and interpret symbols. 2. Interpret terminology used in drawings.
2. Blueprints	1. Read and interpret blueprints for installation, service and maintenance purposes. 2. Demonstrate and use knowledge of drawings in conjunction with an air conditioning instructor.
3. Refrigeration Piping Drawings	1. Read and interpret refrigeration piping diagrams of various layouts using available reference material.
SECTION FIVE: **CONTROLS (THEORY AND SHOP)**	**16 Hours**
A. Review	**2 Hours**
1. Review of Theory	1. Review control theory from second period.
B. Control Systems from Energy Source	**2 Hours**
1. Types of Control Systems Categorized from Energy Source (a) electric (b) pneumatic (c) electronic (d) fluidic (e) self contained (f) hydraulic (g) hybrid (combination)	1. Identify the types of controls used in refrigeration and air conditioning as to energy usage, advantages and disadvantages.
C. Components of Automatic Control Systems	**12 Hours**
1. Components (a) Sensors (i) temperature (ii) humidity	1. Identify sensors, controllers and control devices. 2. Identify and locate auxiliary control equipment as it pertains to a particular control system.

TOPIC	COURSE OBJECTIVES
(iii) flow (v) level (vi) others, flame detection, CO_2, specific gravity, Ph (b) Controllers (i) pneumatic (ii) electric (iii) electronic (iv) fluidic (v) self contained (c) Controlled Devices (i) dampers (ii) valves	

FOURTH PERIOD TECHNICAL TRAINING
COURSE OUTLINE

SECTION ONE: **AIR CONDITIONING AND REFRIGERATION THEORY** **72 Hours**

TOPIC	COURSE OBJECTIVES
	Upon successful completion of each section the apprentice should be able to:
A. Air Conditioning Theory Review **2 Hours**	1. Review air properties. 2. Review basic psychrometric chart construction. 3. Explain the meaning of air conditioning terms, symbols and units of measurement for: (a) wet- and dry-bulb temperature (b) dew point temperature (c) specific and relative humidity (d) enthalpy (e) specific volume (f) grains of moisture (g) barometric pressure
B. Psychrometrics Review **7 Hours**	
1. Psychrometric Chart 2. Air and Apparatus Dew Points 3. Sensible Heat Factor 4. Air Conditioning Heat Load Factors	1. Identify the air conditioning process on a psychrometric chart and show the changes that occur in the condition of the air as it passes through the system: (a) mixtures of air quantities (b) heating and cooling without changing moisture content (c) heating with humidification (d) cooling with constant enthalpy (e) cooling with dehumidification (f) cooling with humidification (g) by-pass factors (h) sensible heat process and factors (i) apparatus dew point 2. Describe the properties of air in relation to the operation of air conditioning systems: (a) composition of air (b) water vapour in air (c) measurement of relative humidity (d) apparatus dew points 3. Determine the exact capacity of an air conditioning system given a psychrometric chart and the following information: (a) entering air volume (b) wet- and dry-bulb temperatures of entering air (c) wet- and dry-bulb temperatures of leaving air
C. Review Refrigeration Load Calculations **4 Hours**	1. Demonstrate knowledge and skills of load calculations learned in other periods.
D. Pressure Enthalpy Diagrams **14 Hours**	
1. P.E. Chart Review (a) P.E. Chart Review (b) Relate Chart to System	1. Review the basic construction of a pressure-enthalpy diagram. 2. Identify specific points and the different zones of the pressure-enthalpy diagram. 3. Plot specific points on the pressure-enthalpy diagram and determine the condition of the refrigerant at these points. 4. Plot a refrigeration cycle onto a pressure-enthalpy diagram, given the evaporating and condensing conditions.

TOPIC	COURSE OBJECTIVES
2. System Calculations	1. Identify and calculate the following data of a refrigeration cycle plotted on a pressure-enthalpy chart: (a) net refrigerating effect (b) weight of refrigerant circulated (c) displacement (d) horsepower required, etc., for different refrigerants (e) saturated suction temperature (f) heat of compression (g) heat picked up per pound in the suction line (h) specific volume of suction vapour entering compressor (i) BTU's per pound of desuper-heating in the condenser (j) system capacity in tons (k) percentage of total load accomplished with sub cooling
E. Equipment Selection and Balance	**20 Hours**
1. Component Selection	1. Select cooling and heating equipment based on: (a) load (b) air circulation (c) ventilating system (d) air cooling system (e) air heating system (f) air cleaning equipment (g) air distribution (h) humidifying and de-humidifying equipment (i) automatic control system
2. Line Sizing	1. Describe and demonstrate sizing techniques based on: (a) evaporating temperature required (b) the capacity of the system at this temperature (c) information and tables to establish equivalent length of piping (d) the type of refrigerant (e) good piping practices
3. High and Low, Side Balance Theory	1. Determine equipment selection by using the high and low side balance theory.
4. Identifying and Correcting System Design Errors	1. Recognize abnormal systems operation due to incorrectly sized piping as follows: (a) undersized piping (b) oversized piping (c) oil return problems 2. Identify mechanical and/or electrical fault in a malfunctioning system and apply systematic trouble shooting procedures in the detection, identification and rectification of the system design error.
F. Ultra-Low Temperature	**6 Hours**
1. Cryogenics	1. Define cryogenics. 2. List common cryogenic fluids used in modern industry. 3. Describe cryogenic applications for modern industry and medicine. 4. Describe safety precautions when operating and servicing cryogenic equipment.
2. Staged Systems	1. Describe the operation of a staged system. 2. List reasons for using a staged system.
3. Cascade Systems	1. Describe principles, operations and applications of a cascade system.
G. Characteristics of Gas Flames	**12 Hours**
1. Review of Air Gas Mixture	1. Demonstrate knowledge and skills learned in the other periods of training.

TOPIC	COURSE OBJECTIVES
2. Hydrocarbons and Combustion	1. Describe the use of sulpher for leak detection in heating equipment. 2. Use a meter to test for carbon monoxide.
3. Gas Burners and Adjustments (a) primary air (b) secondary air (c) oxidizing flame (d) neutral flame (e) carbonizing flame (f) upshot burner (g) inshot burner	1. Describe gas and air mixing in the burner. (a) primary air (b) secondary air 2. Describe gas burner design and types of burners. 3. Describe normal and abnormal flames. 4. Demonstrate adjustments to correct abnormal flames. 5. Describe proper steps in starting a gas furnace.
4. Orifices	1. Describe types and uses of orifices on natural and propane gas-fired heating equipment. 2. Describe and demonstrate use of various sizing tools. 3. Use sizing tables for determining orifice size.
H. Absorption Refrigeration	**3 Hours**
1. Basic Principles and History	1. Review the history of absorption refrigeration and its main uses. 2. Describe the basic principles of operation.
2. Lithium Bromide	1. Describe the basic principles of the lithium bromide cycle. 2. Describe service and maintenance procedures.
I. Code	**4 Hours**
1. B52 Mechanical Code 2. Gas Code	1. Correctly identify the applicable sections of the code, regulations and approved operating instructions covering the installation, maintenance and repair of refrigeration and air conditioning systems for the fourth period.
SECTION TWO: AIR CONDITIONING AND REFRIGERATION SHOP	**72 Hours**
A. Air Conditioning System Design	**17 Hours**
1. Central Air Conditioning System	1. Describe the operation of a central air conditioning system. 2. Perform necessary tests and adjustments to maintain required conditions. 3. Explain how the controls in a typical air conditioning system maintain the required temperature, pressure and humidity in the conditioned space.
2. Measuring Instruments for: (a) cooling cycle (b) heating cycle (c) humidification cycle (d) mixed air cycle	1. Describe and demonstrate correct use, care and maintenance of measuring instruments when operating on the cycles.
3. Air Conditioning Installation	1. Describe an air conditioning installation with special attention to: (a) refrigerant flow controls
4. Plot Measure Information (a) psychrometric charts	1. Record wet- and dry-bulb temperatures and plot information obtained on psychrometric chart.
(b) pressure enthalpy charts	1. Plot specific points on the pressure-enthalpy diagram and determine the condition of the refrigerant.
5. System Problems	1. Analyze system problems with: (a) psychrometric charts (b) pressure enthalpy diagrams

TOPIC	COURSE OBJECTIVES
B. Heating-Cooling Units	**10 Hours**
1. Air Conditions	1. Use instruments necessary for measuring and recording air conditions.
2. System Efficiency	1. Describe the efficiency of this unit as compared to other types.
C. Air Distribution Systems	**12 Hours**
1. Fans	1. Describe the basic functions, types and characteristics of fans used in air conditioning systems and the construction features of centrifugal and axial type fans: (a) components of fans (b) blade construction features (c) fan drive arrangements (d) motor loading (e) direction of rotation (f) installation restrictions
2. Fan Performance	1. Analyse given manufacturer's fan performance curves for various types and sizes of fans and the effect of changing the air flow of the system: (a) R.P.M. (b) horsepower (c) static pressure
3. Duct Systems	1. Describe the function of the duct system, accessories, general duct system arrangements and construction features including: (a) types of duct (b) duct systems (radial, extended plenum, trunk duct, dual-duct) (c) duct fittings and connections (take-offs, elbows, bends, cushion heads) (d) diffusers and other terminal devices (e) directional and throw adjusting device (f) return and exhaust air grilles (g) insulation (h) face and by-pass dampers (i) volume and splitter dampers
4. Pressure Within System	1. Demonstrate how to measure velocity pressure and show how air flow rates are calculated from the pressure readings. 2. Identify and describe fundamentals of air balancing and use air testing instruments.
5. Mixing of Air	1. Establish a systematic, step-by-step method for adjusting and balancing the air flow in an air conditioning system as follows: (a) collect pre-test data including manufacturer's data, design specifications, air distribution system data, fan performance data (b) familiarize self with air distribution specification; examine installed system including schematic layout of main ducts, branches, dampers and terminal units; note air flow design values (c) establish a pre-operational check list for preparing the system (d) establish methods of measuring and adjusting the main air flow, branch duct air flow, registers, and diffusers, including tabulation of results (e) compare the measured air flow and temperature conditions with design values and establish methods to adjust the air flow rates to design values
6. Variable Air Volume Systems	1. Describe the operation of the systems. 2. List its advantages and disadvantages. 3. Describe V.A.V. box construction and repair.
7. Air Flow Problems	1. Describe the reasons for variations in air supply and service requirements to correct such problems as: (a) dirty filters or coils

TOPIC	COURSE OBJECTIVES
	(b) fan speed too low (c) belt slipping (d) dampers or outlets closed (e) restricted ductwork (f) abnormal temperature drop across the cooling coil (g) high humidity due to a warmer coil (h) drafts due to overblow of outlets
D. Specialized Air Conditioning	**10 Hours**
1. Multistaged (Multi-Zone)	1. Describe their functions and principles of operation including use of: (a) evaporators (b) condensers (c) compressors (stages) (d) piping (e) intercoolers and aftercoolers
2. Roof Top Heat-Cool	1. Describe installation procedures including safety precautions, acoustical material and roof leak-proofing. 2. Identify the components of a unit. 3. Describe the principles of operation. 4. Perform service and maintenance procedures. 5. Explain why roof top gas burners use an electric ignition.
3. Data Processing Applications	1. Describe air conditioning used for data processing applications. 2. List reasons for a constant (minimum change) in temperature and humidity in these applications. 3. Explain why a back up unit is necessary if the main unit fails.
4. Heat Pumps	1. Identify and describe the basic operation of heat pumps. 2. Identify and describe heat pump controls and accessories. 3. Identify and describe procedures to select a heat pump system: (a) new (b) add-on 4. Read and interpret manufacturer's installation and servicing data/ instructions: (a) efficiency graphs (b) charging graphs
5. Make Up Air Units	1. Describe requirements for make up air units. 2. Demonstrate procedures required for selection of make up air units.
6. Evaporative Coolers	1. Describe evaporative coolers used to provide humidity and temperature change. 2. Operate an evaporative cooler. 3. Record and assess temperature and humidity readings.
7. Fan Coil Units	1. Describe principles of operation. 2. State its application. 3. Describe service and maintenance procedures.
8. Split Systems	1. Identify a split system and describe principles of operation. 2. State it's application including advantage and disadvantage and simple piping and duct work arrangement. 3. Operate a split system. 4. Record and assess temperature and humidity readings.

TOPIC	COURSE OBJECTIVES
E. Electronic and Mechanical Air Filters	**2 Hours**
	1. Describe the purpose of air filtration, types of filters, construction features and installation methods in air conditioning systems. 2. Explain the principles of operation of air washers, filter purifiers and electronic precipitators. 3. Describe safety precautions to be observed when inspecting or cleaning electrostatic filters. 4. Identify and describe service and maintenance procedures for air cleaner assemblies. 5. Recognize the effects of incorrectly serviced, treated, non-treated, or dirty filters on the air conditioning system.
F. Capacity Control	**4 Hours**
1. Types	1. List and describe currant available capacity control methods.
2. Adjustment	1. Demonstrate adjustments to maintain required conditions.
3. Repair Procedure	1. Apply systematic procedures for service and repair of problems.
G. Industrial Refrigeration Equipment	**8 Hours**
1. Ammonia (a) controls and regulators (b) design (c) troubleshooting	1. Describe controls and regulators used in ammonia systems for: (a) system valves (b) refrigerant control (c) control of oil (d) purging and purgers (e) safety valves 2. Describe the design of an ammonia system and principles of operation. 3. Apply systematic procedures in the detection, identification and rectification of service problems in the refrigeration cycle.
2. Propane Refrigerant Equipment (a) controls and regulators (b) design (c) troubleshooting	1. Describe controls and regulators used in a propane system for: (a) system valves (b) refrigerant control (c) safety valves 2. Describe the design of a propane system and principles of operation. 3. Apply systematic procedures in the detection, identification and rectification of service problems in the refrigeration cycle.
H. Field Trips	**9 Hours**
1. Centrifugal System	1. Describe the basic operation of each system.
2. Absorption System	2. List differences of each in controls.
3. Propane System	3. Describe safety procedures used in the three systems.
SECTION THREE:	**CONTROLS (THEORY AND SHOP)** **96 Hours**
A. Control System	**2 Hours**
1. Review	1. Demonstrate knowledge and skills learned in the other periods of training.
B. Electrical	**25 Hours**
1. Auxiliary Control Equipment (a) electrical auxiliary control equipment (i) transformers (ii) electric relays	1. Identify and locate auxiliary control equipment as it pertains to a particular control system.

TOPIC	COURSE OBJECTIVES
(iii) potentiometers and reostats (iv) manual switches (v) auxiliary switches	
2. Electric Two-Position System (a) two-wire line voltage systems (b) two-wire low-voltage systems (c) line and low-voltage systems	1. Describe each system with respect to: (a) contact ratings (b) low limits (c) high limits (d) heat anticipation (e) cooling anticipation 2. Apply each voltage system to a practical process plant. 3. Demonstrate installation procedures, service and trouble shooting techniques.
3. Three-Wire Two-Position Systems (a) contact action (b) motor circuit	1. Apply three-wire two-position systems to a practical process plant. 2. Demonstrate installation procedures, service and trouble shooting techniques.
4. Multi-Position Sequence (a) heating (b) cooling	1. Describe operations for heating and cooling cycle.
5. Electric Modulating Systems (a) floating control (i) motor reversing (ii) controller action (b) proportional control (i) motor reversing (ii) balancing relay (iii) controller action (iv) high limits (v) low limits	1. Understand the principles, characteristics and applications of electric modulating motors, namely: (a) reversible induction motors (b) reversible shaded pole motors 2. Explain floating control with motors for: (a) motor reversing (b) controller action 3. Explain the basic operation of proportional control and use of motors for: (a) motor reversing (b) balancing relays (c) controller action (d) high and low limits 4. Explain the difference between floating action and proportional action. 5. Demonstrate maintenance, testing and adjustments for floating and proportional control systems. 6. Describe applications of electrical proportional control as they pertain to room thermostats and mixed air economizer.
C. Electronics	**24 Hours**
1. Sensors (a) press (b) temperature (i) thermistor (ii) resistive temperature devices (c) flow	1. Describe the function of sensors and principles of operation. 2. Describe proper location of sensors. 3. Demonstrate installation of sensors.
2. Speed Control	1. Define "speed control" in electronic systems.
3. Motor Protection	1. Describe motor protection in electronic systems.
4. Modulating Devices	1. List modulating devices used. 2. Explain function and principles of operation.
5. Two-Position Devices	1. Describe the function and operating principles of two position devices.
6. Timing Devices	1. List timing devices used for air conditioning and refrigeration.

TOPIC	COURSE OBJECTIVES
(a) air conditioning (b) refrigeration	2. Describe the function of each.
7. Environmental Controls	1. Describe controls used in environmental controls.
8. Alarm Systems	1. Describe safety controls used in systems for: (a) high temperatures (b) low temperatures (c) smoke detectors 2. Describe and demonstrate installation and maintenance procedures.
9. Computerized Systems	1. Describe the function and operating principles. 2. Prepare a short demonstration computer program.
D. Pneumatics	**25 Hours**
1. Air Source	1. Describe sources, pressures, drying and cleaning of air for pneumatic controls.
2. Sensors (a) temperature (i) bi-metal (ii) rod and tube (iii) sealed bellows (iv) remote bulb (b) pressure sensing elements (c) humidity sensing (i) hygroscopic (ii) electrical (iii) photoelectric (d) flow sensing elements (i) heating-cooling (ii) master-submaster (iii) dew-point (iv) dead band	1. Identify and understand different sensors. 2. Describe piping and accessories used in suppling air.
3. Controllers (a) non-relay type (bleed-type) (b) relay-type (c) thermostats (i) day-night (ii) summer-winter	1. Describe types of controllers and principles of operation. 2. Explain how the controls in a typical air conditioning system maintain the controlled variable in the conditioned space. 3. Read and interpret manufacturer's data for the type of control devices in the system.
4. Control Devices (a) actuators (i) standard (ii) positive positioner (b) valves (c) dampers	1. Describe principles of operation and function in the system. 2. Demonstrate the correct maintenance for the servicing of control devices. 3. Explain why a positive positioner may be required in some systems rather than the standard type.
5. Pneumatic Auxiliary Control Equipment (a) electro pneumatic relays (b) pneumatic-electric relays (c) two-position relays (d) proportional relays (e) gradual switches	1. Identify and locate auxiliary control equipment as it pertains to a particular control system.
6. Systems	1. Read and interpret manufacturer's data for the type of controls in the system. 2. Test and adjust controls to maintain operating conditions: (a) pneumatic control system incorporating bleed thermostat and simple damper operator (b) pneumatic controller with thermostat, three-way valves and pressure-electric relay

TOPIC	COURSE OBJECTIVES
	(c) pneumatic control system incorporating year round mixed air economizer system
E. Schematics	**10 Hours**
1. Schematics	1. Read and interpret schematics. (a) electric (b) pneumatic (c) electronic
F. Automatic Gas Controls and Equipment	**10 Hours**
1. Automatic Gas Controls (a) millivolt (b) 24 volt (c) thermocouples (d) thermopiles (e) gas control valves (f) 100% shut off valves (g) safety switches (i) limit controls (ii) fan/limit controls	1. Describe function and operating principles of each. 2. Demonstrate testing and replacement of each. 3. Explain the difference between thermocouples and thermopiles. 4. Explain the operation of safety switches when extreme temperatures are reached. 5. Read and interpret wiring schematic diagrams.
2. Valves (a) gas valves (i) diaphragm (ii) solenoid (iii) hydro-motor (b) pressure regulating (c) gas cocks	1. Describe the function and operative principles of each. 2. Demonstrate testing and servicing of each.
3. Ignition and Control Devices (a) standing pilot (b) spark ignition	1. List ignition and control devices for standing pilots and spark ignitions. 2. Describe function and principles of operation for each. 3. Perform maintenance, adjustments and servicing of each.
4. Flame Safety	1. Demonstrate testing the flame safeguard system with a millivolt meter: (a) open circuit test (b) closed circuit test 2. Use proper meter scales for checking thermocouples and thermopiles. 3. Identify unsafe flame characteristics. 4. Identify causes of unsafe flame characteristics and demonstrate correct procedures to remedy these.

SUGGESTED REFERENCE MATERIALS

Modern Refrigeration and Air Conditioning — 1982 — Edition — Althouse, Turnquist and Bracciano

Refrigeration Engineering Data — Dunham — Bush Inc.

Modern Refrigeration Practice — G. R. King

Refrigeration Engineering Manual — Keeprite Products Ltd.

Control Systems for Heating, Ventilating and Air Conditioning — Roger M. Haines

B 52 Mechanical Refrigeration Code — Latest Edition

Electric Circuits and Machines — 5th Edition — Lister

Introduction to Electricity and Electronics — Loper and Ahr

Electrical Machines — 2nd Edition — Siskind

Electric Motor Control — Walter N. Alerich

Automatic Control of Heating and Air Conditioning — J. E. Haines

B149.1 and B149.2 — M-80-Canadian Gas Association

Canadian Electrical Code — Latest Edition — Canadian Standards Association

Occupational Health and Safety Regulations — Latest Edition

Refrigeration and Air Conditioning by Langley

Electricity for Refrigeration, Heating and Air Conditioning by Russell E. Smith

TECHNICAL TRAINING SCHOOLS

The Refrigeration Mechanic apprenticeship training program is offered by Alberta Manpower, Apprenticeship and Trade Certification. Staff and facilities for teaching the program are supplied by:

1. Southern Alberta Institute of Technology

LOCATION OF APPRENTICESHIP AND TRADE CERTIFICATION REGIONAL OFFICES

BONNYVILLE

CALGARY

EDMONTON

FORT MCMURRAY

GRANDE PRAIRIE

HINTON

LETHBRIDGE

MEDICINE HAT

PEACE RIVER

RED DEER

VERMILION

GOVERNMENT OF THE PROVINCE OF ALBERTA

ALBERTA REGULATION 420/83

(Filed on December 2, 1983)

MANPOWER DEVELOPMENT ACT

MINISTERIAL ORDER

I, Ernie Isley, Minister of Manpower, pursuant to sections 30(2) and 37(2) of the Manpower Development Act, hereby make the Regulation in the attached Appendix being the Refrigeration Mechanic Trade Amendment Regulation.

DATED at Edmonton, Alberta this 1st day of December, 1983

ERNIE ISLEY
MINISTER OF MANPOWER

A P P E N D I X

MANPOWER DEVELOPMENT ACT

Refrigeration Mechanic Trade Amendment Regulation

1 The Refrigeration Mechanic Trade Regulation (Alta. Reg. 108/83) is amended by this regulation.

2 Section 1(1)(b) is amended by adding "including a person who repairs or maintains combination units for heating or cooling of buildings with a maximum heating capacity of 120 kW (400 000 B.T.U. -h) input" *after* "components".

GOVERNMENT OF THE PROVINCE OF ALBERTA

ALBERTA REGULATION 108/83

(Filed on April 7, 1983)

MANPOWER DEVELOPMENT ACT

MINISTERIAL ORDER

I, Ernie Isley, Minister of Manpower, pursuant to sections 30(2) and 37(2) of the Manpower Development Act, hereby make the Regulation in the attached Appendix, being the Refrigeration Mechanic Trade Regulation.

DATED at Edmonton, Alberta, this 6th day of April, 1983.

ERNIE ISLEY
Minister of Manpower

APPENDIX

MANPOWER DEVELOPMENT ACT

Refrigeration Mechanic Trade Regulation

1(1) In this regulation

(a) "General Regulations" means the General Regulations under the *Manpower Development Act* (Alta. Reg. 43/77);

(b) "refrigeration mechanic" means a person engaged in the installation, maintenance, service or repair of primary or secondary refrigeration systems, cooling systems or their components;

(c) "trade" means the trade of refrigeration mechanic.

(2) The definitions in the General Regulations apply in this regulation.

PART 1

APPRENTICESHIP AND TRADE TRAINING

2 A person is eligible to be an apprentice in the trade if he satisfies the requirements of section 5 of the General Regulations and either

(a) produces evidence of at least a grade 9 education, or the equivalent, or

(b) passes the entrance examination prescribed by the Board.

3(1) Subject to subsections (2), (3) and (4), an employer who is a journeyman, or who employs a journeyman, may employ one apprentice and may employ one additional apprentice for each additional journeyman he employs.

(2) If the supply of journeymen in a location where an employer is carrying on business is insufficient to permit the employer to carry out his work commitments, the Director may authorize the employer to employ apprentices in addition to those permitted under subsection (1).

(3) The Director may authorize an employer to employ an apprentice in addition to those under subsections (1) and (2) on a temporary basis to train him in a branch of the trade not engaged in by the person to whom he is apprenticed.

(4) An apprentice employed temporarily under subsection (3) shall not, for the purpose of subsections (1) and (2), be considered to be an apprentice of his temporary employer.

4(1) The term of apprenticeship shall be 4 periods of 12 months each.

(2) Each period referred to in subsection (1) shall consist of not less than 1800 hours of employment inclusive of time spent attending technical training courses prescribed by the Board.

(3) The Director may not, pursuant to section 25(1) of the Act, reduce the term of apprenticeship to be served by an apprentice to less than one period of apprenticeship.

5 When a contract of apprenticeship is registered with the Director, he shall issue to the apprentice an official record book referred to in section 14 of the General Regulations.

6(1) An apprentice shall not advance to the next period until the Director has authorized him to do so by making an entry in the apprentice's official record book under subsection (2).

(2) The Director shall make an entry in the apprentice's official record book authorizing advancement to the next period when the apprentice

(a) has completed the previous period of apprenticeship,

(b) has received, in the opinion of the Director, a satisfactory report from

(i) his employer, and

(ii) the school at which he attended technical training courses prescribed by the Board,

(c) has completed the tests and examinations prescribed by the Board, and

(d) has attained passmarks prescribed by the Board in the tests and examinations referred to in clause (c).

7 The official record book of an apprentice shall be kept in the possession of his employer and, on termination of the employment of the apprentice, the employer shall present the completed book to him.

8(1) An employer shall pay to an apprentice wages that are not less than the following percentages of the prevailing wages paid to a journeyman:

(a) 50% in the first period;

(b) 60% in the 2nd period;

(c) 75% in the 3rd period;

(d) 85% in the 4th period.

(2) Notwithstanding subsection (1), the wages paid to an apprentice shall not be less than the minimum wage fixed pursuant to the *Employment Standards Act*.

(3) An employer is not required to pay wages to an apprentice during the time that the apprentice spends attending technical training courses prescribed by the Board.

9 The hours of work and working conditions of an apprentice shall be the same as those of a journeyman.

PART 2

CERTIFICATION

10 In accordance with section 49(b) of the General Regulations, the Director may issue the following classes of certificates:

(a) Certificate of Proficiency;

(b) Temporary Certificate.

11 In accordance with section 50(d) of the General Regulations, the Director may issue a Certificate of Proficiency for the trade without examination to a person who holds

(a) a Certificate of Completion of Apprenticeship issued by another province of Canada, or

(b) a Certificate of Qualification or a Certificate of Proficiency bearing an Interprovincial Standards Red Seal issued by another province of Canada.

12(1) An application to take an examination for a Certificate of Proficiency shall be made to the Director.

(2) Documentary evidence acceptable to the Director shall be presented by an applicant for an examination showing that the applicant

(a) holds a certificate equivalent to an Alberta Certificate of Proficiency issued by a provincial authority outside Alberta, or

(b) has at least 4 years of acceptable work experience in the trade.

(3) The applicant shall provide translations into the English language, acceptable to the Director, of credentials in a language other than English submitted pursuant to subsection (2).

13(1) The Director may issue a Temporary Certificate to a person if

(a) that person has complied with section 12;

(b) the Director has approved the application for examination made under section 12(1), and

(c) the applicant has attained a mark of not less than 70% of the passmark on the examination prescribed by the Board.

(2) Notwithstanding subsection (1)(c), the Director may, when in his opinion extenuating circumstances warrant such action, issue a Temporary Certificate to a person who has attained a mark of less than 70% of the passmark on the examination prescribed by the Board.

(3) A Temporary Certificate entitles the holder to work as a refrigeration mechanic under the supervision of a journeyman.

14 A Certificate of Proficiency issued under this regulation is effective unless cancelled or suspended by the Director in accordance with section 60 or 61 of the General Regulations or section 48 of the *Manpower Development Act*.

15 Alberta Regulations 158/57 and 399/66 are repealed.

1468